African indigenous vegetables, gender, and the political economy of commercialization in Kenya

Sarah Hackfort[1] · Christoph Kubitza[1] · Arnold Opiyo[2] · Anne Musotsi[3] · Susanne Huyskens-Keil[1]

Abstract

This study investigates the increased commercialization of African indigenous vegetables (AIV)—former subsistence crops such as African nightshade, cowpea leaves and amaranth species grown mainly by women—from a feminist economics perspective. The study aims to answer the following research question: How does AIV commercialization affect the gendered division of labor, women's participation in agricultural labor, their decision-making power, and their access to resources? We analyze commercialization's effects on gender relations in labor and decision-making power and also highlight women's agency. Based on a mixed method design and analyzing household-level panel data and qualitative focus groups from Kenya, we observe an economic empowerment of women that we relate to women's individual and collective strategies as well as their retention of control over AIV selling and profits. Yet, while we see economic empowerment of women through commercialization—how they broaden their scope of action and are empowered by generating revenue—that does not contribute to a redistribution of labor or land rights, which are key for gender equality, instead it increases women's labor burden.

Keywords African indigenous vegetables · Commercialization · Mixed methods · Feminist economics · Sub-Saharan Africa

Introduction

Sub-Saharan African countries are experiencing rising food insecurity and malnutrition aggravated by price shocks and disrupted supply chains, investment funds speculating in commodities markets, and climate change impacts (FAO et al. 2021; Agarwal et al. 2022). Fostering the production of African indigenous vegetables (AIV) is regarded as one strategy to create nutrition-sensitive and resilient value chains to support people's livelihoods in many sub-Saharan African countries (Bokelmann et al. 2022). AIV are indigenous plant species in Africa, which are well adapted to local environmental conditions, known for their climate resilience and nutritional and health-promoting value (Towns and Shackleton 2018; Ghanem 2022). AIV include, for example, species such as amaranth (*Amaranthus ssp*), African nightshade (*Solanum nigrum*), spider plant (*Cleome gynandra*), cowpea leaves (*Vigna unguiculata*), pumpkin leaves (*Cucurbia maxima, C. pepo*), and jute mallow (*Corchorus olitorius*).

For decades, AIV were mostly grown by women and for subsistence, in kitchen gardens or in intercropped farming systems but rarely at larger scales. The last decade, however, witnessed the beginning of a shift from AIV being low-scale subsistence crops to being an important income source as well as a significant part of urban food consumption (Bokelmann et al. 2022). This is driven by rising demand from urban consumers (Gido et al. 2017), increasing acceptance of traditional local food, awareness campaigns, and an increase in nutritional and health concerns that can be addressed through the consumption of AIV (Kamga et al. 2013; Gido et al. 2017; Mwadzingeni et al. 2021).

Transition from subsistence to commercial agriculture is sometimes regarded as a precondition for income generation and the alleviation of poverty (Tuni et al. 2022), particularly

✉ Sarah Hackfort
sarah.hackfort@hu-berlin.de

[1] Thaer-Institute of Agricultural and Horticultural Sciences, Faculty of Life Sciences, Humboldt-Universität zu Berlin, Berlin, Germany

[2] Department of Crops, Horticulture and Soils, Egerton University, Egerton, Kenya

[3] Department of Nutritional Sciences, School of Public Health, Biomedical Sciences and Technology, Masinde Muliro University of Science and Technology, Kakamega, Kenya

in countries where small-scale farming is still common. Various studies document a positive relationship between agricultural commercialization, income, and improved nutrition (Fischer and Qaim 2012; Krause et al. 2019; Ogutu et al. 2020). Others, however, critically emphasize both the adverse effects on (female) smallholders, including new dependencies (from men or markets), and the limitations and unequal distribution of the benefits of commercialization (Park and Maffii 2017; Gironde et al. 2021; Prügl et al. 2021). Due to the heterogeneity of the literature in this context, this study uses the case of AIV in Western Kenya to investigate, from a feminist economics perspective, the effects of commercialization on smallholder farmers, especially in regard to the distribution of benefits.

Conceptually, this article draws on works of feminist economics in agriculture, which have emphasized the changing character of social reproduction in contexts of commercialization and its uneven benefits when formerly non-market transactions become subject to market principles (Bhattacharya 2017; Razavi 2009). Such a perspective places particular emphasis on the analysis of gender inequalities in labor and decision-making power in crop production, including in access to resources such as independent income from agricultural labor; it also highlights the agency of women (Agarwal 1992; Razavi 2003). Based on a mixed methods study in Kenya, this article aims to answer the following research question: How does AIV commercialization affect the gendered division of labor, women's participation in agricultural labor, their decision-making power, and their access to resources?

The commercialization of African indigenous vegetables in Kenya

Due to the need for income generation within smallholder farming systems, rapid urbanization in many sub-Saharan countries, and urban consumers' demand for and dependence on local agricultural production, most smallholder farmers today supplement their livelihood by selling part of their production at markets. In various countries, evidence shows that market participation has increased across income classes and cropping systems (Carletto et al. 2017). Kenya's smallholder farmers follow this trend, as various studies document commercialization across different crops, including bananas (Fischer and Qaim 2012), exotic vegetables (Muriithi and Matz 2015), cassava (Opondo et al. 2020), and also AIV (Krause et al. 2019).

AIV have been cultivated in sub-Saharan Africa for centuries, were regularly grown in home gardens or alongside cash crops (e.g., sugar cane), and formed an integral part of the rural diet (Abukutsa-Onyango 2007). Yet they were often seen only as "edible weeds" or "poor man's food" and thus were not grown on larger scales or sold at markets (Brückner 2020). For a long time, AIV production was distinctly different from that of cash crops for two major reasons: First, AIV are a key component of local dietary diversity and only little commercialized. Second, they were traditionally produced by women as subsistence crops (Mwadzingeni et al. 2021). For instance, a recent study from Kenya showed that in AIV production and marketing, women had a greater share of involvement compared to other crops (Deißler et al. 2021).

Today, however, AIV are slowly emerging from the shadows of subsistence production; increasingly, they are purchased and sold commercially as conventional horticultural crops. Due to the informality of the sector, there exists neither precise annual aggregate production data nor data on the share of production sold at markets. Survey data from 2003/2004 indicated that 90% of respondents perceived an increase in demand (Abukutsa-Onyango 2007). This trend was driven by rising demand from urban consumers (Gido et al. 2017), the increasing acceptance of traditional local food, awareness campaigns, and an increase in nutrition- and health-related concerns that could be addressed through the consumption of AIV (Kamga et al. 2013; Gido et al. 2017; Mwadzingeni et al. 2021). For some, AIV are also an important and cherished alternative to the existing food system, for instance, to exotic kale (*Brassica oleracea* var. *acephala*), which enjoys dominant popularity (Abukutsa-Onyango 2007; Brückner 2020). Based on various recent literature, AIV are reported to be increasingly commercialized in local and regional markets within the region covered by the present study and throughout East Africa. For this study, AIV commercialization in smallholder horticulture is defined as a shift in the purposes of production, away from subsistence or exchange without compensation and toward commercial purposes and income generation.

Some literature reports on the positive effects of AIV commercialization on income (Ngenoh et al. 2016; Krause et al. 2019) as well as nutrition indicators such as dietary diversity (Krause et al. 2019) and contribution to human health measures (e.g., Odongo et al. 2018). Within this strand of literature, the inclusion of smallholder producers in commercial agricultural value chains is seen as a means of generating independent income and economic growth and thus contributing to social inclusion. In general, advancing commercialization to assure the inclusion of disadvantaged groups in terms of income, jobs, and access to food is a well-established focus of the literature on smallholder farming in the Global South (Andersson et al. 2015; Meemken et al. 2019), with women being one of the primary groups of concern (Doss 2001).

Positive assessments of the commercialization of agricultural crops are challenged by critical literature that points to the unequal distribution of the benefits of
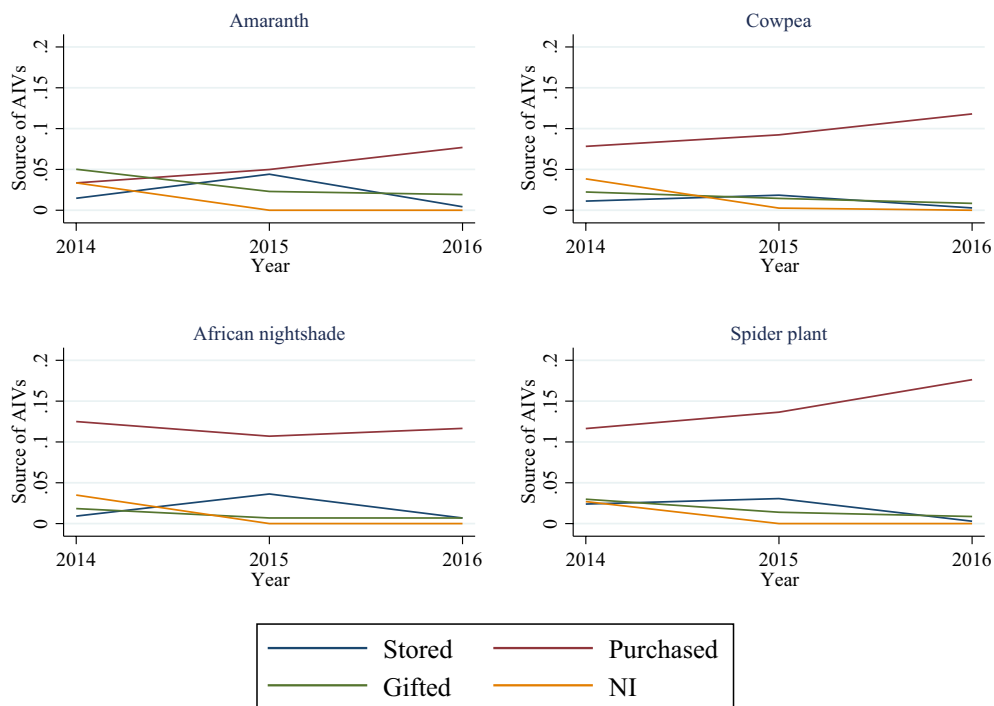
Notes: Source of AIVs refers to the origin of AIVs consumed by the households. The remaining source of AIVs consumed is from own production which is not listed.

Fig. 1 Sources of AIVs for household consumption

commercialization among men and women and to the risk of women losing control of production and becoming disempowered should men enter into and take over the production of former subsistence crops. Commercialization can go hand in hand with the dispossession of smallholder farmers—making them dependent on agricultural value chains as wage workers on plantations or as contract farmers producing for export markets—and hence can aggravate existing social inequalities (Dolan 2001; Njuki et al. 2011; Park and Maffii 2017; Gironde et al. 2021; Prügl et al. 2021). Moreover, some empirical studies find little improvement in nutritional outcomes as a result of commercialization (Carletto et al. 2017).

The existing literature on commercialization is therefore ambiguous and points in different directions. Quantitative data resulting from, for example, the application of more robust estimation techniques using panel data, as well as qualitative evidence on the gendered effects of the commercialization of AIV in Kenya, is limited. Studies in sub-Saharan Africa show that the allocation of resources such as land and fertilizer is highly inefficient, with too few resources applied to crops cultivated by women (Apedo-Amah et al. 2020). Interviews frequently

reported that also for AIV, male household heads allocated only small pieces of land to their wives for AIV cultivation but adjusted resource allocation when AIV began generating revenue (Ferenczi 2021). This suggests that when men take over decision-making related to production, they may allocate more land to AIVs, potentially leading to an increase in yield (Brückner 2020).

Through this transmission mechanism, AIV production and self-consumption can also increase along with an increase in male decision-making. Access to land is also an important production bottleneck. Farm size has been on the decline for several decades in Kenya, and arable land is extremely scarce (Jayne et al. 2003). Yet women's access to and control over land in Kenya is particularly limited. Despite progressive formal legislation that aims at gender equality and legal opportunities for women to possess land, it is still very rare for them to hold land rights and de facto control over decision-making. According to the Federation of Women Lawyers, while women head about 32% of households, they individually hold only 1% of land titles (Mbugua 2020; Federation of Women Lawyers n.d.).

Table 1 Effect of changing gender responsibilities on commercialization—household-level FE models (2015–2016)

	(1) Share of amaranth sold (0–1)	(2) Share of cowpea leaves sold (0–1)	(3) Share of African night-shade sold (0–1)	(4) Share of spider plant sold (0–1)
Men responsible for production (=1)	− 0.012	0.151***	0.005	0.200***
	(0.071)	(0.050)	(0.043)	(0.068)
Size of land for respective crop (ha)	0.045	0.054	0.204	0.317
	(0.385)	(0.076)	(0.245)	(0.253)
HHH age	− 0.012**	0.017***	− 1.8e-5	0.002
	(0.005)	(0.006)	(0.004)	(0.004)
HHH male (=1)	− 0.016	− 0.759***	− 0.166	− 0.243
	(0.144)	(0.100)	(0.150)	(0.163)
HHH married (=1)	0.060	0.001	0.050	− 0.069
	(0.100)	(0.072)	(0.066)	(0.078)
HHH migrated (=1)	− 0.148	0.244**	0.083	− 0.024
	(0.125)	(0.109)	(0.070)	(0.112)
HHH with primary education (=1)	− 0.010	0.381***	0.064	0.280**
	(0.108)	(0.098)	(0.084)	(0.118)
HHH with secondary education (=1)	− 0.103	0.292***	0.032	0.151
	(0.092)	(0.100)	(0.082)	(0.102)
Number of HH members	− 0.001	0.044	− 0.019	0.064*
	(0.045)	(0.032)	(0.033)	(0.034)
Number of adult HH members	− 0.016	− 0.025	− 0.024	− 0.037
	(0.039)	(0.036)	(0.028)	(0.035)
Farm size (ha)	− 0.020	− 0.012	0.024	0.008
	(0.015)	(0.011)	(0.023)	(0.010)
Asset index (quintiles)	0.012	− 0.033*	0.018	0.011
	(0.021)	(0.019)	(0.014)	(0.019)
Receiving rent (=1)	0.146*	− 0.077	− 0.011	0.197*
	(0.078)	(0.088)	(0.062)	(0.105)
Own business (=1)	0.010	− 0.091	0.026	0.006
	(0.053)	(0.064)	(0.048)	(0.064)
Constant	1.033**	− 0.216	0.598*	0.014
	(0.439)	(0.375)	(0.323)	(0.327)
F-stat	1.016	5.623	1.232	2.571
R2	0.049	0.133	0.038	0.132
Observations	797	699	1087	671

Data from HORTINLEA surveys 2015 and 2016. Average marginal effects are reported with clustered standard errors at the household level in parentheses. Year dummies are included

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

Overall, this qualitative evidence also suggests that gender relations strongly shape the allocation of household responsibilities and resources in the setting of our current study (Bakare-Yusuf 2003).

Analyzing commercialization from a feminist economics perspective

To better understand the distributive effects of commercialization, this study conducts a political economy analysis building on conceptual work in feminist economics. It focuses the interrelationship between gender and the

economy and emphasizes the relevance of a gendered understanding of institutions and economic processes (including at the family and household levels) (Waylen 2000; Agenjo-Calderón and Gálvez-Muñoz 2019). Feminist economics brings "the domestic arena into the analytical framework" (Razavi 2009, p. 200) of economic analyses. Through a critique of the assumptions of neoclassical economics, the approach extends the analysis of economic processes to the political economy of the household, including both gender inequalities and other social inequalities. It draws attention to the weaknesses of neoclassical economics by emphasizing reproductive work as a "background condition" of production and economic value and by problematizing the gendered division of labor (Razavi 2009, p. 211). Feminist economics includes household dynamics as constitutive of gender inequalities, problematizing the division of labor based on the assignment of reproductive work and care work, which are generally unpaid, to women and productive work to men and arguing for the need for redistribution of labor to achieve gender equality. Furthermore, feminist economics problematizes the victimization narrative in agricultural, development, and environmental politics, which suggests that women are merely passive observers of change. It emphasizes women's agency—that is, their ability to define goals and strategically act (and react) to achieve them (Kabeer 1999, p. 438; Hackfort and Burchardt 2018)—in order to "challenge their unequal economic, social and political positions and advance towards parity" (Agarwal 2020, p. 842).

This study builds on work done within feminist economics that is concerned with the political economy of agriculture, which places particular emphasis on gender in agricultural labor and crop production decision-making. This includes the access to resources such as independent income, capital, or agricultural technologies; to political or social organizations and institutions, especially those that are postcolonial and patriarchal in nature; and to the ownership of land (Agarwal 1992; Razavi 2003; Tsikata 2016; Prügl et al. 2021). In line with such an approach, in this study, gender inequalities are understood as a matter of political economy. Furthermore, the effects of the commercialization of AIV are analyzed according to their impacts on the gendered division of labor; decision-making power in the household and beyond; social and political organization; and women's access to resources, as well as their strategies for gaining and maintaining this access. As feminist economics has pointed out, such analyses need to include intra-household interaction and the complex dynamics of "both cooperation and conflict" (Agarwal 1997, p. 4) as important features of gender relations as well as negotiations over decision-making power and the division of labor with regard to the overall economic success of the household (Razavi 2009).

Material and methods

This study is based on a mixed method design encompassing a panel survey and focus group discussions. A survey of farm households was conducted in two counties in western Kenya (Kisii and Kakamega) and two in central Kenya (Kiambu and Nakuru) as part of HORTINLEA, one of our previous larger interdisciplinary research project (Kebede et al. 2018). The panel survey was repeated in three rounds, which took place in 2014, 2015, and 2016. Because key variables such as questions about the gendered responsibility for selling were only included in the 2015 and 2016 surveys, we excluded 2014 data from the main analysis. A multi-stage sampling framework was used to obtain a sample of local farm households. In the first stage, sub-counties and division areas were purposively selected. In the second stage, wards were randomly selected, while farm households were again randomly selected within the wards. Sampling was conditional on households consuming, marketing, or producing AIV (Kebede et al. 2018). Surveys were conducted from September to October using structured questionnaires. Interviews were carried out by one enumerator in person in the local language. Respondents were the most knowledgeable household members on household and farming details which were usually the male household head and/or his wife. For the present study, only households that were observed across all 3 years—685 households in total—were selected.

For the quantitative data analysis, we estimated the effect of changing household responsibilities according to gender using the following linear regression model with household-level fixed effects,

$$Y_{ivt} = \beta_o + \beta_1 G_{ivt} + \beta_2' Z_{ivt} + \beta_3' X_{it} + \gamma_t + \mu_i + \varepsilon_{ivt}, \qquad (1)$$

where Y_{ivt} is the share of produce sold by household i for vegetables v by year t. G_{ivt} is our key variable, being a dummy variable for responsibility for production (1 = men). Z_{ivt} includes crop-specific control variables. X_{it} is a vector of household-level control variables. The year fixed effects γ_t control for year-specific shocks, and the household fixed

effects μ_i control for time-invariant differences across households. ε_{it} is the error term.

Throughout the analysis, we used a fixed-effects specification while reporting the random-effects model results as an additional robustness check due to their higher efficiency. A Hausman test rejected the null hypothesis that the preferred model is random effects. We also regressed our key variable, responsibility for production in cultivated areas, to observe whether additional changes in the production system took place.

While the quantitative data help to understand the patterns of exclusion and their effects on different welfare indicators, more subtle changes in the quality of relations and potential coping strategies are not captured with regression models. To draw a more complete picture of the gendered effects of commercialization, we use qualitative methods.

Qualitative data were collected 6 years later, in 2022, as part of another research project that focused on the social cohesion aspects of AIV production. In total, 20 group interviews were conducted in 10 communities in the counties of Kisii and Kakamega, the same communities where the survey took place. In Kisii, selection of participants was done through the County Agricultural Extension Officers, whereas in Kakamega, it was done through the Butere-Mumias Traditional Vegetables Cooperative Society. Major sub-counties engaging in AIV production were identified and lists and contacts of households and groups involved in AIV production were provided from which potential respondents for the interviews were randomly selected and invited. Eventually, each group consisted of 8–10 women and men, separated by gender, and took place in the same regions and communities as the quantitative survey, though not within the same households. The interviews were conducted by Kenyan enumerators in the national language (Swahili) and later translated into English. A qualitative data analysis (QDA) using the software MAXQDA was conducted on the interviews. All transcripts have been deductively coded by a team of up to three researchers using the analytical categories that are key in the feminist economics framework (gendered division of labor and participation in agricultural labor, decision-making and access to resources, and women's agency and strategies).

We do not consider the time gap between qualitative and quantitative data collection as problematic because the phenomena under study are longstanding enough to be captured by both types of data. Moreover, we designed the question guide to also reflect changes that have occurred over recent decades, as changes in the AIV production system are likely to be incremental and evolve only over longer periods of time. In addition, the qualitative interviews serve not only to collect more evidence of the effects of AIV commercialization on gender relations but also to test the external validity of the quantitative results.

Results and discussion

Our panel data corroborate our hypothesis, that AIV are increasingly bought and sold. Figure 1 shows that purchases of AIV became more common; for spider plants, for example, they increased from 12 to 18% in only 2 years. It was only for nightshade that sales stagnated. The giving of AIV as a gift was marginally common in the initial year of the study, 2014, but by 2016, it had become relatively uncommon—for amaranth, for instance, the share of total gifted vegetables decreased from 5 to 2% (Fig. 1).[1] The results clearly show an increase in the purchase of AIV over time.[2] The increased selling of vegetables that would previously have been shared or given as gifts, is supported by qualitative findings and statements by the respondents—for example, quote 1:

> Quote 1: Traditionally, you could hear people tell their neighbors to come and pick some vegetables. That's what women used to do. Right now, they cannot do that because it translates to money, and this has reduced relations because everyone is now business-minded, and when they look at the AIV, they see money and not friendship. (Man from West Marama, paragraph 131)

---

[1] Further descriptive statistics are provided in Tables 3 and 4 in the appendix.

[2] In Table 4, the share sold increases only for spider plants and African nightshade, not for amaranth and cowpea leaves. However, production data seem to fluctuate strongly, which could be due to seasonal effects and also outliers and measurement errors. We interpret the descriptive evidence in the production data with caution and use household-fixed effects models to adjust for measurement units that are often unique to the household. We assume that some of the measurement error is nested within respondents as they might use similar packaging systems over time. The respondents hence systematically under- or overreport yields, which will be partly addressed by the fixed-effects model.

In the following subsections, we present our findings on the gendered effects of commercializing AIV in our regions of study.

Gendered division of labor and women's participation in agricultural labor

In the past, women cultivated AIV in home gardens and as subsistence crops. The data show, however, that AIV cultivation is no longer exclusively their domain. The panel data show that agricultural commercialization is associated with men taking over AIV production, at least in the cases of cowpea leaves and spider plants (see Table 1).[3] This is corroborated by the qualitative data, as many respondents from both groups confirm (e.g., as in quote 2) that men, once they see that it is profitable, are increasingly entering the AIV business. Yet interestingly, although men are taking over responsibilities related to production, only very few women report being excluded from the agricultural labor associated with growing AIV. Instead, the findings indicate that women feel supported and assisted in the AIV production process by men taking part in commercialization and taking over responsibilities and duties, as quotes 2 and 3 demonstrate.

> Quote 2: Since commercialization, people have stopped referring to the production of AIV as a women's venture. Now the men have started cultivating and selling these AIV too. Nowadays, the men can come in the farm and help the woman in weeding because they have seen money flowing. (Woman from Getenga, paragraph 19)
>
> Quote 3: It is a relief now that men are assisting us. In the past, every work was done by women, but today it is easy, as we work together. We assist one another. (Woman from Magenche, paragraph 151)

While both women and men are involved in AIV production, a gendered division of labor characterizes the production of AIV for commercial sales. Even if some discussants denied gender-related assignments of tasks, the data show that, along the value chain, tasks and responsibilities are largely gendered: men prepare the land, clearing, digging, and mixing the soil. Women do the planting, weeding, plucking, harvesting, and selling of the AIV at local markets. Men also spray pesticides, but they are less involved in selling AIV directly to consumers at local markets, which is considered a woman's task. Yet, as quote 4 indicates, men are involved when it comes to organizing logistics, arranging transportation by motorbike (*boda-boda*), and selling in larger quantities and at larger scales—to, for example, traders, schools, or hotels.

> Quote 4: Yes, they are doing a lot. But we men also do most of the work in land preparation—carrying, transportation and spraying. But harvesting we can also do, but women do it much better. (Man from Bobasi, paragraph 265)

This is confirmed by the quantitative data, which show that men's selling activity has not increased with commercialization. Table 7 shows no consistent association between men taking over responsibility for selling AIV and the share of AIV being sold, with the exception of a single crop, for which we do find a significant positive association: amaranth. In addition, at a level of 10 percent, the association is only weakly significant. Reasons for men's low level of selling activity given by both groups are that they "lack the knowledge" to pick the plants correctly, break down what they harvest into small quantities, quantify these, and negotiate prices at local markets. According to the women, they lack the social skills required to profitably market and sell at local markets, as quote 5 below perfectly illustrates:

> Quote 5: Who will buy from a man? They can sell cabbages and Sukuma wiki in bags, but how will they even break down the African nightshade in small quantities and sell? They don't know how to do it. (Womean from Nyacheki, paragraph 194)

Male and female respondents both confirmed that women's workload has increased with the commercialization of AIV; as they have begun producing for markets, their burdens have mounted. While women have always weeded and harvested, they now also sell their vegetables at markets, which requires leaving the homestead. At the same time, they are still responsible for the provision of care work, including childcare and providing food for the whole family. Hence, there is no evidence for a redistribution of labor within the household (e.g., quote 6).

> Quote 6: Work has increased because apart from taking care of the farm and selling AIV in the market, you also have other chores—like taking care of the children—while at the same time, you don't have anyone to help you. (Woman from West Kisa, paragraph 137)

Even with AIV becoming profitable and men taking over production responsibilities, our data indicate a gendered division of labor along the value chain and no redistribution of productive or reproductive labor; women weed, harvest,

---

[3] These results are highly significant even if we control for household-level fixed effects. The results are robust to using random-effects models (Table 5) and increasing the time span to 2014–2016 (Table 6). We did not find the differences to be based on differential price developments between various AIV based on local market data. Instead, we attribute the finding to limited variability in our key variable over time. We also note that, using the models cited, we cannot determine whether men take over *when* commercialization increases or if men take over and *then* commercialization increases.

Table 2 Effect of changing gender responsibilities on cultivated area—household-level FE Models (2015–2016)

	(1) Cultivated area (ha) for amaranth	(2) Cultivated area (ha) for cowpea leaves	(3) Cultivated area (ha) for African nightshade	(4) Cultivated area (ha) for spider plant
Men responsible for production (=1)	0.011	0.036*	0.008	0.045**
	(0.014)	(0.021)	(0.009)	(0.020)
HHH age	1.14e-4	0.003	0.001	0.001
	(0.001)	(0.002)	(0.001)	(0.001)
HHH male (=1)	− 0.076**	− 0.111***	− 0.017	− 0.021
	(0.037)	(0.033)	(0.023)	(0.034)
HHH married (=1)	0.037*	0.041	0.015	0.032
	(0.021)	(0.027)	(0.011)	(0.024)
HHH migrated (=1)	− 0.045	0.007	0.007	− 0.020
	(0.042)	(0.027)	(0.015)	(0.017)
HHH with primary education (=1)	− 0.012	0.062	0.012	− 0.019
	(0.031)	(0.043)	(0.016)	(0.027)
HHH with sec. education (=1)	− 0.016	0.078*	0.006	− 0.031
	(0.032)	(0.047)	(0.016)	(0.024)
Number of HH member	0.014**	0.023***	0.013*	0.018
	(0.007)	(0.008)	(0.007)	(0.012)
Number of adult HH members	− 0.019***	− 0.019	− 0.009	− 0.015**
	(0.006)	(0.014)	(0.007)	(0.008)
Farm size (ha)	− 0.007	− 0.012	0.002	0.002
	(0.006)	(0.011)	(0.006)	(0.004)
Asset index (quintiles)	0.009**	− 0.016	0.007**	0.001
	(0.004)	(0.033)	(0.004)	(0.006)
Receiving rent (=1)	0.028*	0.020	0.006	0.008
	(0.016)	(0.023)	(0.011)	(0.018)
Own business (=1)	− 0.019	0.031	0.003	− 0.008
	(0.024)	(0.029)	(0.015)	(0.016)
Constant	0.050	− 0.124	− 0.055	− 0.070
	(0.068)	(0.180)	(0.054)	(0.077)
F-stat	1.815	4.609	1.356	1.301
R2	0.090	0.027	0.032	0.072
Observations	785	687	1070	662

Data from HORTINLEA surveys 2015 and 2016. Average marginal effects are reported with clustered standard errors at the household level in parentheses. Year dummies are included

$*p < 0.10, **p < 0.05, ***p < 0.01$

and sell the produce at local markets, while men spray pesticides and trade only at greater distances. This can be interpreted in line with indications gleaned from our data that even though men have entered the realm of AIV production, women do not feel excluded from agricultural labor; instead, they see men's activity as assistance. At the same time, they do not perceive a significant decrease in their own workload. Regarding this latter point, it can be concluded that when men get involved in AIV production, they take over less time-consuming tasks, such as logistics and spraying pesticides, while women retain the more time-consuming tasks of agricultural labor. Women's tasks include care work

in the homestead and possibly also the background work of prepping less-visible farm-related tasks, such as arranging or cleaning equipment.

This resonates with findings from other regions of the world, which show how women in India, for instance, actively work in the background of agricultural production, carrying out "invisible" preparatory and pre-production work related to activities taking place both on and off the farm. As a result, women's labor burden can increase considerably without being recognized as having done so (Pattnaik and Lahiri-Dutt 2022). This mirrors the general feminist dilemma represented by the tension between, on

the one hand, the demand that women be enabled to economically empower themselves through participation in the "productive economy" and, on the other, the increase in workload caused by additional wage labor—on top of the reproductive and care work women are typically responsible for. When women enter the productive sphere without men taking on reproductive work in turn, their workload significantly increases. Consequently, demanding a redistribution of labor and involving men more extensively in care work are key concerns of feminist economics; as our data show, these issues are relevant in our case study region, too. "Just slotting women *in"* (Agenjo-Calderón and Gálvez-Muñoz 2019, p. 148, italics in original) may help to achieve inclusion in an economy with an unjust, gendered labor market, but it does not help achieve gender equality. Toward that goal, feminist economics highlights another key concern: redefining the concept of labor. Gender equality requires (in addition to a redistribution of labor) a recognition of the myriad activities through which women provide for and contribute to productive labor; it requires that women's invisible agricultural labor, for instance, become visible (Fraser 1995; Pattnaik and Lahiri-Dutt 2022).

Women's decision-making power and access to resources

On the question of whether women gain or lose decision-making power when men take on responsibilities and duties in relation to AIV production, the quantitative data are not unambiguous. For instance, the quantitative analysis shows, at least for cowpea leaves and spider plants, that agricultural commercialization is associated with men taking over decision-making in the production (but not selling) of AIV (see Tables 1 and 7 in the appendix). The same holds for the qualitative data, which reveal that as AIV are successfully produced for sale, men increasingly begin to see their economic potential and get involved in the production and decision-making processes, including deciding what to plant and where and how to spend any revenue, as quote 7 demonstrates:

> Quote 7: In most cases, it's the man who decides where the AIV and other crops will be planted. As a woman, you cannot just farm anywhere because you will ignite a conflict. Before commercialization, you could just plant anywhere—only for consumption purposes—but currently, you can't just plant anywhere because he knows that's your money. So you have to discuss and agree on where you will do your AIV production. (Woman from Central Marama, paragraph 188)

How this influences women's effective decision-making power seems to depend on the arrangements within individual households. According to some women, unlike in the past, men now want to have a say in how revenue from AIV, as additional household income, is spent. Others say that they decide on their own what to buy or invest in and then inform their husband about their decisions. Some respondents from both the female and male groups, meanwhile, report discussing and making decisions about these kinds of questions as a couple, with both parties having an equal say, as in quote 8.

> Quote 8: If I go to the market and sell the vegetables, I will buy [a] few items. When I go back home, I will tell my husband I got 500 [Kenyan] Shillings after selling the vegetables. I have spent 300. Here are the remaining 200, which we discuss how to use. (Woman from Bobasi, paragraph 222)

However, a large number of statements indicate that after commercialization, women's decision-making power in regard to the use of income increases. Even with men entering the AIV business, a number of women declare that they have gained decision-making power, freedom, and the ability to autonomously decide how to spend the money they earn (as in quote 8). This is likely to be linked to the quantitative finding that while men have increased their decision-making power in relation to production, they have not done so with regard to the selling of AIV at markets; at this stage, women have direct control over the income earned. Through this access to financial resources, they perceive an increase in their freedom to decide whether to use the money for household purchases, farm inputs, or livestock and even how to use the land—including whether to increase the amount used to cultivate AIV, as quote 9 notes.

> Quote 9: They [women] have gained decision-making responsibilities in the household. They can now suggest to the man to increase the size of farm that they used to cultivate AIV. (Woman from West Marama, paragraph 28)

For many women, selling AIV is a strategy to diversify their income and livelihood. These women articulate having gained economic independence with the additional income they earn through commercialization. They state that they have "'gained decision-making responsibilities" (as in quote 9) and perceive themselves as economically empowered, as they have their own income. They feel that they have more freedom and decision-making power (see quote 10), which contributes to a move toward more gender equality in the household.

> Quote 10: When we cultivate the AIV and start selling, we, the women, gain more rights in decision-making within the household. We can contribute in deciding the size of land that will be used for AIV farming and

also the type of seed to be planted. (Woman from Kholera, paragraph 175)

These women broaden their scope of action by not relying on their husbands to give them money for household expenses. With the income generated, they contribute to their household income and thus help make life easier and investments possible. In some cases, men even seem to rely on the money that women now contribute, as quote 11 indicates.

Quote 11: I can even give my husband some pocket money, like 200 Shillings, therefore bringing peaceful coexistence. (Woman from Getenga, paragraph 11)

Overall, the qualitative and quantitative results suggest that by retaining control over selling AIV, women perceive no loss in decision-making power; at markets, they receive money directly from their customers and hence control the monetary reward to some extent. In addition, if men mostly enter AIV production through improved household cooperation, by this same route, women can gain access to resources that are under the control of men (such as land) or develop strategies to cope with new allocations of household responsibilities (see quote 9).

Cooperation in the household and beyond

Cooperation between men and women as household members—with regard to AIV production and the use of revenues—is a recurrent theme in the qualitative data. Despite the gendered division of labor, AIV production is perceived as a common and cooperative activity that contributes to the economic success of the household. It is pursued as a strategy of income diversification in which it is in the best interest of the family that both men and women contribute, participate, and decide. Quite a number of couples decide together how to satisfy household, family, and individual needs; what the money should be spent on or how it should be saved; and how to use the land, as quotes 12, 13, and 14 show.

Quote 12: Personally, I do a lot of AIV farming, but we both sell and we put all the monies together for common use, so in my household, my woman is fine. Additionally, we mutually agree on the items to spend money on. (Man from west Marama, paragraph 99)

With men engaging in AIV production, households are more likely to better allocate resources (including material inputs and land) between different crops. Indeed, households seem to increase the area of the land cultivated for AIV if men assume production responsibilities (see Table 2), which is in line with anecdotal evidence from previous studies (Ferenczi 2021). In addition, qualitative evidence also shows that access to and control over the use of land is an important part of household cooperation, as quotes 13–14 illustrate.

Quote 13: It will bring more benefits if they get involved because he can even cut on maize production and increase the portion of land on which to plant AIV, and that will make it more profitable. (Woman from Khalaba, paragraph 280)
Quote 14: For the land they [the couple] want to cultivate indigenous vegetables for commercial purposes; they sit down and discuss the size of the land to allocate to indigenous vegetables production, and also they discuss the selling of the vegetables. They decide together. (Man from Kholera, paragraph 194)

Cooperation and the resulting improvement in a household's economic situation are expected to benefit the whole family. Moreover, many women highlight the economic independence they have gained as being conducive to more harmony and peace and less conflict in the household and within the family.

Examples of household cooperation aside, however, in cases where there is no intra-household cooperation, many women develop individual coping strategies. Some admit to lying to their husbands in order to keep their savings, in case they or their families need them, as quote 15 shows.

Quote 15: Sometimes, we lie about the sales from the vegetables. If, for instance, after buying few items and I am left with 200 Shillings, I will tell him I am left with 150 and keep the 50 undisclosed. I hide it in my home bank. The savings come in handy in times of need. (Woman from Bobasi, paragraph 281)

This resonates with feminist studies that emphasize how intra-household dynamics encompass conflictive and cooperative arrangements simultaneously when access to, use of, and control over resources and the distribution of work, time, and responsibilities are negotiated (Agarwal 1997; Agenjo-Calderón and Gálvez-Muñoz 2019). This shows the complex interplay between the "common interests that all household members have in the overall economic success of their households" (Razavi 2009, p. 208) and other, less cooperative individual strategies that women develop.

To summarize, when AIV are successfully produced for sale, men get more involved in their production and any associated decision-making. However, the data show that this does not necessarily translate into decreased decision-making power for women. Instead, it suggests that the increased commercialization of AIV benefits women in the form of access to financial resources and, indirectly, an increase in their influence over production inputs such as land. With the revenues they obtain from the production and selling of AIV, women gain access to income streams that not only diversify their livelihoods, ensuring food security,

but also further contribute to their economic empowerment and, eventually, to the strengthening of their decision-making power. In the literature, this latter effect is considered a main indicator of bargaining power within the household and beyond (Agarwal 1997; Acosta et al. 2020; Orr et al. 2021). From a feminist economics perspective, these dimensions are key to achieving gender equality and reducing the social exclusion of women (Kabeer 1999).

However, it must be noted that these strategies are limited with regard to overcoming gendered inequalities inherent in the structures of patriarchal societies. This is illustrated by the fact that when men decide to dedicate a greater share of land to AIV production (as quote 13 mentions), women must negotiate with them to access it; land is not a resource that women are able to independently access or gain control over. Land ownership and control are ultimately patriarchal, and men have the final say over land use, including the share that is dedicated to AIV production. Some women declare that should men enter into and take over AIV production, they themselves will withdraw from it and venture into other businesses—for instance, selling other vegetables, cows, or hens; poultry production; or manual labor, even if these activities may be less profitable and more labor-intensive than commercial AIV production.

Furthermore, many women use collective strategies such as social organizing in small groups to pool resources and support each other through, for example, financial loans. These banking and savings cooperatives, called "merry-go-rounds" (*chamas* in Kiswahili), are very popular among women in these regions. Some women were first able to diversify their livelihoods with these group savings; they enable them to lease land together, for example, or invest in a cow to eventually produce manure to boost AIV production.

> Quote 28: It has brought women together through formation of women groups, whereby they lease land as a group, prepare the lands for cultivating the AIVs together, weed together and harvest the AIVs together. (Woman from Getenga, paragraph 19)

Forming groups also helps them to build relationships along the AIV value chain to better access markets beyond the local village by setting up a system of AIV distribution. The groups also enable them to access agricultural inputs like energy or machinery through the acquisition of external funding, as well as obtain political resources through government support (from agricultural extension officers, for example). As a result of past agricultural reforms (which were part of neoliberal structural adjustment policies), governmental regional agricultural extension officers reach out only after communities demand that they do so, meaning that only organized groups are able to benefit and obtain information and support from these officers.

In this way, women develop individual and collective strategies to diversify their livelihoods and gain more economic independence. They build networks of solidarity and support as a self-help strategy that is conducive to, simultaneously, political empowerment and economic independence. With regard to the effects of commercialization, women successfully use these strategies to meet their immediate daily needs. In feminist scholarship terms, they can be understood as "practical gender interests"—as opposed to "strategic gender interests" (Molyneux 1985, p. 232–233), which aim much more at the transformation of patriarchal structures as such (for example, collective struggles to obtain land rights instead of just accessing land via a husband). These practical interests are legitimate and essential for women who experience the contradiction of, on the one hand, being part of a household and cooperative coalition with their husbands while, on the other, needing to find ways to, as women, overcome dependence and foster empowerment in a patriarchal society. Our data suggest that these women's strategies are also fundamental to their agency and to determining their intra-household bargaining and decision-making power. They contribute to women's empowerment, defined as the ability to make life choices enabled by access to material and immaterial social resources, agency, and achievements that relate to well-being (Kabeer 1999). It becomes apparent how women, against the backdrop of the commodification of their crops and subsistence labor, rely on such collective strategies to secure their livelihoods and how monetization requires such informal strategies to function at all.

Conclusions

This study examines the commercialization of AIV and analyzes how it affects gender relations, that is the division of labor, decision-making power and access to resources, and cooperation strategies. Feminist economists have criticized the commodification of formerly non-market transactions and goods and pointed out that "women's integration in the labor market has not implied automatic liberation, even if, from a historical and comparative perspective, it has served to challenge rather than consolidate patriarchal structures." (Agenjo-Calderón and Gálvez-Muñoz 2019, p. 159). It is therefore important to analyze how such processes affect gender relations in regard to resources, rights, and responsibilities and the kinds of conflicts and cooperation women and men engage in to balance their needs as both individuals and household and family members.

This study shows that while commercialization is conducive to men's increased involvement in AIV production and related decision-making, this does not necessarily translate into decreased decision-making power for women. If women

retain control over selling vegetables (and hence, keep the resulting income in their own hands), they maintain and even enhance their bargaining and decision-making power. This specific finding—that women in the study region are able to retain control over income—could potentially have been a key factor in avoiding the detrimental effects of commercialization that are reported in the literature (Fischer and Qaim 2012). The results indicate that more attention should be paid not only to which tasks are redistributed among men and women but also to those tasks' inherent characteristics, including working conditions, their effects on health, and control over income and land use.

Furthermore, household members cooperating to reach individual or common goals can also be perceived as support, as men taking over what have traditionally been women's tasks. Yet, rather than just defending their domain and developing strategies for (for instance) retaining the monetary reward for attaining their goals, women also develop strategies for withdrawal. This shows that the binary of household cooperation versus household conflict—and the immediate assumption that there is no household cooperation—cannot capture complex intra-household dynamics.

The results corroborate findings from other studies, which show that where women's bargaining power is stronger, agricultural or horticultural commercialization is likely to result in more equal benefits for both women and men (Orr et al. 2021). Apart from social norms, the legal institutions of the labor market, and state policies, it is largely power relations and women's bargaining power within the family that determine whether and to what degree women perceive and experience increases in their decision-making power and overall empowerment through the commercialization of "their" crops. This indicates that

"context determines who wins from commercialization" (Orr et al. 2021, p. 251).

Yet, against this rather optimistic assessment for some settings, it should be noted that women in our study still suffer from a growing workload; more and more labor goes toward the selling of AIV, while at the same time, they still have to perform most care work. Also, with regards to land ownership as a key concern from a feminist economics perspective, the results are ambivalent—the commercialization of AIV replaces the subsistence farming of AIV when land availability is a bottleneck for production, as is the case for women in Kenya, whose access to land and possession of land titles are limited due to patriarchal inheritance practices. Thus, our study illustrates that women's experiences vary and that overly simplistic and dichotomous assessments of the effects of commercialization as generally positive are not valid.

To conclude, while we see the economic empowerment of women through commercialization—how they broaden their scope of action and are empowered by generating revenue—that process does not contribute to a redistribution of labor or land rights, which are key for gender equality. In contrast, women's labor burden has increased. Moreover, with the commodification of subsistence work and previously subsistence crops as common goods, social practices (selling instead of gifting or sharing, for example) may be entirely replaced by market-based forms of interaction. To what degree this might erode the bonds of solidarity and social cohesion needs to be further explored.

Appendix

See Tables 3, 4, 5, 6, and 7.

Table 3 Summary statistics for household variables

	2015			2016		
	N	Mean	SD	N	Mean	SD
HHH age	684	51.667	12.552	685	52.702	12.643
HHH male (=1)	684	0.820	0.384	685	0.819	0.385
HHH married (=1)	684	0.825	0.381	685	0.851	0.356
HHH migrated (=1)	684	0.026	0.160	685	0.048	0.214
HHH Primary education (=1)	684	0.386	0.487	685	0.365	0.482
HHH Higher education (=1)	684	0.558	0.497	685	0.572	0.495
Number of HH members	684	5.921	2.330	685	6.105	2.365
Number of adult HH members	684	3.845	1.848	685	4.095	1.911
Farm size (ha)	684	0.993	1.386	685	0.989	1.338
Asset score (quintiles)	684	2.993	1.411	685	3.000	1.415
Receiving rent (=1)	683	0.100	0.300	685	0.140	0.347
Own business (=1)	684	0.254	0.436	685	0.247	0.431

Data from HORTINLEA surveys 2015 and 2016

Table 4 Summary statistics on AIV production

	2015			2016		
	N	Mean	SD	N	Mean	SD
Amaranth						
Production (kg)	433	276.293	589.491	356	114.298	166.408
Production sold (kg)	433	177.744	525.975	356	58.512	124.040
Share sold (0–1)	433	0.351	0.359	356	0.323	0.334
Men responsible for production (=1)	432	0.234	0.424	354	0.220	0.415
Men responsible for selling (=1)	243	0.160	0.368	186	0.161	0.369
Size of land (ha)	433	0.039	0.070	356	0.035	0.074
Cowpea leaves						
Production (kg)	372	222.646	346.276	319	111.820	151.531
Production sold (kg)	372	126.619	272.906	319	65.324	124.701
Share sold (0–1)	372	0.427	0.352	319	0.408	0.344
Men responsible for production (=1)	370	0.262	0.440	318	0.201	0.402
Men responsible for selling (=1)	252	0.159	0.366	204	0.132	0.340
Size of land (ha)	372	0.061	0.101	319	0.062	0.234
African nightshade						
Production (kg)	546	338.564	771.309	531	159.867	271.537
Production sold (kg)	546	216.650	576.331	531	107.832	232.162
Share sold (0–1)	546	0.440	0.362	531	0.469	0.341
Men responsible for production (=1)	543	0.243	0.429	528	0.208	0.407
Men responsible for selling (=1)	368	0.168	0.375	369	0.154	0.362
Size of land (ha)	546	0.052	0.102	531	0.042	0.060
Spider plant						
Production (kg)	353	318.660	846.123	317	169.748	249.228
Production sold (kg)	353	219.072	759.035	317	107.353	205.016
Share sold (0–1)	353	0.403	0.355	317	0.439	0.342
Men responsible for production (=1)	347	0.236	0.425	315	0.178	0.383
Men responsible for selling (=1)	225	0.138	0.345	211	0.161	0.369
Size of land (ha)	353	0.046	0.079	317	0.039	0.058

Data from HORTINLEA surveys 2015 and 2016

Table 5 Effect of changing gender responsibilities on commercialization—household-level random effects models (2015–2016)

	(1) Share of Amaranth sold (0–1)	(2) Share of Cowpea leaves sold (0–1)	(3) Share of African Night-shade sold (0–1)	(4) Share of Spider plant sold (0–1)
Men responsible for production (=1)	0.036	0.094***	0.049*	0.051
	(0.031)	(0.033)	(0.026)	(0.034)
Size of land for respective crop (ha)	0.585**	0.031	0.389*	0.815***
	(0.253)	(0.085)	(0.202)	(0.193)
Age of HHH	− 0.001	− 8.5e-5	− 0.001	3.8e-4
	(0.001)	(0.001)	(0.001)	(0.001)
Female HHH	− 0.016	− 0.004	− 0.030	0.001
	(0.054)	(0.055)	(0.045)	(0.056)
Married HHH (=1)	− 0.011	− 0.023	− 0.042	− 0.080
	(0.057)	(0.052)	(0.044)	(0.052)
HHH migrated (=1)	0.149**	0.123*	0.158***	0.011
	(0.064)	(0.073)	(0.051)	(0.073)
HHH with primary education (=1)	0.042	0.146***	0.122***	0.124**
	(0.048)	(0.054)	(0.047)	(0.060)
HHH with secondary education (=1)	− 0.002	0.120**	0.107**	0.063
	(0.048)	(0.056)	(0.048)	(0.061)
Number of HH member	− 0.020**	0.002	0.003	3.7e-4
	(0.009)	(0.009)	(0.008)	(0.009)
Number of adult HH members	0.015	− 0.003	− 0.007	− 0.004
	(0.010)	(0.012)	(0.010)	(0.011)
Farm size (ha)	− 0.007	0.002	0.005	− 0.006
	(0.007)	(0.011)	(0.010)	(0.008)
Asset index (quintiles)	0.012	0.006	0.018**	0.019*
	(0.009)	(0.010)	(0.008)	(0.010)
Receiving remittances (=1)	0.004	− 0.082*	− 0.061*	− 0.030
	(0.034)	(0.046)	(0.035)	(0.042)
Own business (=1)	0.021	0.036	0.043	0.030
	(0.029)	(0.033)	(0.027)	(0.033)
Constant	1.033**	− 0.216	0.598*	0.014
	(0.439)	(0.375)	(0.323)	(0.327)
Chi^2	104.183	39.302	119.009	82.575
Observations	797	699	1087	671

Data from HORTINLEA surveys 2015 and 2016. Average marginal effects are reported with clustered standard errors at the household level in parentheses. Year dummies are included

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

Table 6 Effect of changing gender responsibilities on commercialization—household-level fixed effects models (2014–2016)

	(1) Share of Amaranth sold (0–1)	(2) Share of Cowpea leaves sold (0–1)	(3) Share of African Nightshade sold (0–1)	(4) Share of Spider plant sold (0–1)
Men responsible for production (= 1)	− 0.058	0.124***	− 0.006	0.161***
	(0.053)	(0.041)	(0.031)	(0.049)
Size of land for respective crop (ha)	0.108	0.017	0.124	0.227
	(0.279)	(0.044)	(0.142)	(0.182)
Age of HHH	− 0.005	0.002	− 4.9e-5	1.8.e-4
	(0.003)	(0.004)	(0.002)	(0.002)
Female HHH	0.060	− 0.068	− 0.040	− 0.103
	(0.107)	(0.113)	(0.077)	(0.102)
Married HHH (= 1)	0.122	0.012	0.078*	− 0.010
	(0.078)	(0.055)	(0.046)	(0.056)
HHH migrated (= 1)	− 0.014	0.050	0.051	− 0.068
	(0.090)	(0.078)	(0.051)	(0.051)
HHH with primary education (= 1)	− 0.092	0.161**	− 0.023	0.082
	(0.079)	(0.067)	(0.056)	(0.076)
HHH with secondary education (= 1)	− 0.135	0.087	0.004	0.055
	(0.082)	(0.080)	(0.059)	(0.074)
Number of HH member	0.016	0.048**	0.012	0.026
	(0.034)	(0.020)	(0.018)	(0.021)
Number of adult HH members	− 1.9.e-4	− 0.014	− 0.013	− 0.027
	(0.031)	(0.025)	(0.019)	(0.026)
Farm size (ha)	0.004	0.002	0.014	0.004
	(0.013)	(0.011)	(0.013)	(0.010)
Asset index (quintiles)	0.010	0.011	0.007	0.025*
	(0.015)	(0.015)	(0.010)	(0.014)
Receiving remittances (= 1)	− 0.005	− 0.150**	− 0.018	0.023
	(0.058)	(0.066)	(0.046)	(0.059)
Own business (= 1)	0.007	− 0.022	0.054	0.041
	(0.046)	(0.046)	(0.033)	(0.046)
Constant	0.460*	− 0.151	0.089	0.009
	(0.257)	(0.251)	(0.189)	(0.208)
F-stat	0.760	3.644	15.392	6.963
R^2	0.023	0.105	0.217	0.207
Observations	999	906	1462	898

Data from HORTINLEA surveys 2014, 2015 and 2016. Average marginal effects are reported with clustered standard errors at the household level in parentheses. Year dummies are included

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

Table 7 Effect of changing gender responsibilities in selling on commercialization—household-level fixed effects models (2015–2016)

	(1) Share of Amaranth sold (0–1)	(2) Share of Cowpea leaves sold (0–1)	(3) Share of African Night-shade sold (0–1)	(4) Share of Spider plant sold (0–1)
Men responsible for selling (=1)	0.149*	− 0.048	− 0.018	0.134
	(0.079)	(0.065)	(0.052)	(0.106)
Size of land for respective crop (ha)	0.153	− 0.064	− 0.078	− 0.037
	(0.402)	(0.228)	(0.204)	(0.195)
Age of HHH	− 0.005	− 0.008	− 0.001	− 0.005
	(0.007)	(0.006)	(0.004)	(0.008)
Female HHH	− 0.079	− 0.423***	− 0.190	− 0.085
	(0.140)	(0.073)	(0.147)	(0.141)
Married HHH (=1)	− 0.028	− 0.107*	0.091	− 0.111
	(0.107)	(0.065)	(0.076)	(0.074)
HHH migrated (=1)	0.009	0.020	0.022	0.112
	(0.168)	(0.095)	(0.078)	(0.162)
HHH with primary education (=1)	− 0.024	0.266	− 0.052	0.071
	(0.096)	(0.166)	(0.091)	(0.113)
HHH with secondary education (=1)	− 0.054	0.256*	0.003	0.047
	(0.095)	(0.135)	(0.082)	(0.101)
Number of HH member	− 0.100**	− 0.034	− 0.048	0.061*
	(0.049)	(0.037)	(0.034)	(0.032)
Number of adult HH members	− 0.004	− 0.005	− 0.016	− 0.053
	(0.055)	(0.047)	(0.031)	(0.042)
Farm size (ha)	− 0.012	− 0.012	0.009	− 0.001
	(0.010)	(0.009)	(0.019)	(0.012)
Asset index (quintiles)	− 0.019	− 0.013	0.007	0.007
	(0.024)	(0.020)	(0.014)	(0.017)
Receiving remittances (=1)	0.048	0.060	0.065	0.307***
	(0.074)	(0.116)	(0.069)	(0.097)
Own business (=1)	− 0.071	0.034	0.023	0.054
	(0.064)	(0.052)	(0.043)	(0.066)
Constant	1.631***	1.487***	1.105***	0.739
	(0.481)	(0.383)	(0.342)	(0.546)
F-stat	1.147	12.366	1.472	2.222
R^2	0.120	0.113	0.086	0.232
Observations	440	468	753	444

Data from HORTINLEA surveys 2015 and 2016. Average marginal effects are reported with clustered standard errors at the household level in parentheses. Year dummies are included

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

Data availability Data analyzed in this study is available from the corresponding author on reasonable request.

Declarations

Conflict of interest The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/.

References

Abukutsa-Onyango, Mary. 2007. The diversity of cultivated African leafy vegetables in three communities in Western Kenya. *African Journal of Food, Agriculture, Nutrition and Development* 7 (3): 85–91.

Acosta, Mariola, Margit van Wessel, Severine van Bommel, Edidah L. Ampaire, Jennifer Twyman, Laurence Jassogne, and Peter H. Feindt. 2020. What does it mean to make a 'joint' decision? Unpacking intra-household decision making in agriculture: Implications for policy and practice. *The Journal of Development Studies* 56 (6): 1210–1229. https://doi.org/10.1080/00220388.2019.1650169.

Agarwal, Bina. 1992. The gender and environment debate: Lessons from India. *Feminist Studies* 18 (1): 119–158. https://doi.org/10.2307/3178217.

Agarwal, Bina. 1997. "Bargaining" and gender relations: Within and beyond the household. *Feminist Economics* 3 (1): 1–51. https://doi.org/10.1080/135457097338799.

Agarwal, Bina. 2020. Does group farming empower women? Lessons from India's experiments. *Journal of Peasant Studies* 47 (4): 841–872. https://doi.org/10.1080/03066150.2019.1628020.

Agarwal, Kabir, Thin Lei Win, and Margot Gibbs. 2022. 'Betting on hunger': Market speculation is contributing to global food insecurity. https://thewire.in/economy/speculation-is-contributing-to-global-food-insecurity-significantly.

Agenjo-Calderón, Astrid, and Lina Gálvez-Muñoz. 2019. Feminist economics: Theoretical and political dimensions. *American Journal of Economics and Sociology* 78 (1): 137–166. https://doi.org/10.1111/ajes.12264.

Andersson, Camilla I.M.., Christine G.K.. Chege, Elizaphan J.O.. Rao, and Matin Qaim. 2015. Following up on smallholder farmers and supermarkets in Kenya. *American Journal of Agricultural Economics* 97 (4): 1247–1266. https://doi.org/10.1093/ajae/aav006.

Apedo-Amah, Marie Christine, Habiba Djebbari, and Roberta Ziparo. 2020. *Gender, Information and the Efficiency of Household Production Decisions: An Experiment in Rural Togo*. IZA Discussion Papers 12948. Bonn.

Bakare-Yusuf, Bibi. 2003. 'Yorubas don't do gender': A critical review of Oyeronke Oyewumi's the invention of women: Making an African sense of western gender discourses. *African Identities* 1 (1): 119–140. https://doi.org/10.1080/1472584032000127914.

Bhattacharya, Tithi. 2017. *Social reproduction theory: Remapping class, recentering oppression*. London: Pluto Press.

Bokelmann, Wolfgang, Susanne Huyskens-Keil, Zoltan Ferenczi, and Silke Stöber. 2022. The role of indigenous vegetables to improve food and nutrition security: Experiences from the project HORTINLEA in Kenya (2014–2018). *Frontiers in Sustainable Food Systems* 6: 1–19. https://doi.org/10.3389/fsufs.2022.806420.

Brückner, Meike. 2020. *Biodiversity in the kitchen, cooking and caring for African indigenous vegetables in Kenya: A feminist approach to food sovereignty*. München: Oekom Verlag.

Carletto, Calogero, Paul Corral, and Anita Guelfi. 2017. Agricultural commercialization and nutrition revisited: Empirical evidence from three African countries. *Food Policy* 67: 106–118. https://doi.org/10.1016/j.foodpol.2016.09.020.

Deißler, Luzia Karin, Henning Krause, and Ulrike Grote. 2021. Gender dynamics and food security in the kenyan african indigenous vegetables supply chain. *International Association of Agricultual Economists. Virtual Conference*, August 17–31. https://ideas.repec.org/p/ags/iaae21/314983.html. Accessed 14 April 2023.

Dolan, Catherine. 2001. The 'good wife': Struggles over resources in the Kenyan horticultural sector. *Journal of Development Studies* 37 (3): 39–70. https://doi.org/10.1080/00220380412331321961.

Doss, Cheryl R. 2001. Designing agricultural technology for African women farmers: Lessons from 25 years of experience. *World Development* 29 (12): 2075–2092. https://doi.org/10.1016/S0305-750X(01)00088-2.

FAO, IFAD, UNICEF, WFP, and WHO. 2021. *The state of food security and nutrition in the world 2021: Transforming food systems for food security, improved nutrition and affordable healthy diets for all*. Rome: FAO.

Federation of Women Lawyers (n.d.). *Women's land and property rights in Kenya: A training handbook*. Kenya. https://land.igad.int/index.php/documents-1/countries/kenya/gender-3/625-women-s-land-and-property-rights-in-kenya/file. Accessed 30 July 2022.

Ferenczi, Zoltán M. 2021. *Analysis of poverty traps in rural smallholder households in East Africa*. PhD Disseration, Humboldt-Universität zu Berlin, Berlin.

Fischer, Elisabeth, and Matin Qaim. 2012. Gender, agricultural commercialization, and collective action in Kenya. *Food Security* 4 (3): 441–453. https://doi.org/10.1007/s12571-012-0199-7.

Fraser, Nancy. 1995. From redistribution to recognition? Dilemmas of justice in a 'post-socialist' age. *New Left Review* 1 (212): 68–93.

Ghanem, Michel Edmond. 2022. Africa's forgotten crops could offset growing food insecurity. *Nature* 605: 30. https://doi.org/10.1038/d41586-022-01185-1.

Gido, Eric Obedy, Oscar Ingasia Ayuya, George Owuor, and Wolfgang Bokelmann. 2017. Consumer acceptance of leafy african indigenous vegetables: Comparison between rural and urban dwellers. *International Journal of Vegetable Science* 23 (4): 346–361. https://doi.org/10.1080/19315260.2017.1293758.

Gironde, Christophe, Fenneke Reysoo, Andres Torrico Ramirez, and Seng Suon. 2021. No cash, no food: Gendered reorganization of livelihoods and food security in Cambodia. *Journal of Peasant Studies* 48 (7): 1485–1506. https://doi.org/10.1080/03066150.2021.1960826.

Hackfort, Sarah, and Hans-Jürgen. Burchardt. 2018. Analyzing socio-ecological transformations—A relational approach to gender and climate adaptation. *Critical Policy Studies* 12 (2): 169–186. https://doi.org/10.1080/19460171.2016.1191363.

Jayne, T.S., Takashi Yamano, Michael T. Weber, David Tschirley, Rui Benfica, Antony Chapoto, and Ballard Zulu. 2003. Smallholder income and land distribution in Africa: Implications for poverty reduction strategies. *Food Policy* 28 (3): 253–275. https://doi.org/10.1016/S0306-9192(03)00046-0.

Kabeer, Naila. 1999. Resources, agency, achievements: Reflections on the measurement of women's empowerment. *Development and Change* 30 (3): 435–464. https://doi.org/10.1111/1467-7660.00125.

Kamga, R., C. Tchientche, A.R. Kouamé, Takemore Chagomoka Atangana, and R. Ndango. 2013. Nutritional evaluation of five African indigenous vegetables. *Journal of Horticultural Research* 21 (1): 99–106. https://doi.org/10.2478/johr-2013-0014.

Kebede, Sindu W., Henning Krause, Evans Ngenoh, Hillary Bett, Anja Faße, and Wolfgang Bokelmann. 2018. *Hortinlea baseline survey report 2014*. Hannover Economic Papers (HEP) 641. Leibniz Universität Hannover, Wirtschaftswissenschaftliche Fakultät, Hannover. https://ideas.repec.org/p/han/dpaper/dp-641.html. Accessed 18 April 2023.

Krause, Henning, Anja Faße, and Ulrike Grote. 2019. Welfare and food security effects of commercializing African indigenous vegetables in Kenya. *Cogent Food & Agriculture* 5 (1): 1700031. https://doi.org/10.1080/23311932.2019.1700031.

Mbugua, Sophie. 2020. In Kenya's changing climate, women are claiming land rights to feed their families. *Climate Home News.* 2020. https://www.climatechangenews.com/2020/12/18/kenyas-changing-climate-women-claiming-land-rights-feed-families/.

Meemken, Eva-Marie., Jorge Sellare, Christophe N. Kouame, and Matin Qaim. 2019. Effects of Fairtrade on the livelihoods of poor rural workers. *Nature Sustainability* 2 (7): 635–642. https://doi.org/10.1038/s41893-019-0311-5.

Molyneux, Maxine. 1985. Mobilization without emancipation? Women's interests, the state, and revolution in Nicaragua. *Feminist Studies* 11 (2): 227–254. https://doi.org/10.2307/3177922.

Muriithi, Beatrice W., and Julia Anna Matz. 2015. Welfare effects of vegetable commercialization: Evidence from smallholder producers in Kenya. *Food Policy* 50: 80–91. https://doi.org/10.1016/j.foodpol.2014.11.001.

Mwadzingeni, Learnmore, Victor Afari-Sefa, Hussein Shimelis, Sognigbé N'Danikou, Sandiswa Figlan, Lutz Depenbusch, Admire I.T.. Shayanowako, Takemore Chagomoka, Malven Mushayi, Pepijn Schreinemachers, and John Derera. 2021. Unpacking the value of traditional African vegetables for food and nutrition security. *Food Security* 13: 1215–1226. https://doi.org/10.1007/s12571-021-01159-7.

Ngenoh, Evans, Sindu W. Kebede, Hillary K. Bett, and Wolfgang Bokelmann. 2016. Role of high-value market participation on poverty reduction among African leafy vegetable farmers in Kenya. *African Journal of Horticultural Science* 10: 14–20.

Njuki, Jemimah, Susan Kaaria, Angeline Chamunorwa, and Wanjiku Chiuri. 2011. Linking smallholder farmers to markets, gender and intra-household dynamics: Does the choice of commodity matter? *The European Journal of Development Research* 23 (3): 426–443. https://doi.org/10.1057/ejdr.2011.8.

Odongo, Grace Akinyi, Nina Schlotz, Susanne Baldermann, Susanne Neugart, Susanne Huyskens-Keil, Benard Ngwene, Bernhard Trierweiler, Monika Schreiner, and Evelyn Lamy. 2018. African nightshade (Solanum scabrum Mill.): Impact of cultivation and plant processing on its health promoting potential as determined in a human liver cell model. *Nutrients* 10 (10): 1532. https://doi.org/10.3390/nu10101532.

Ogutu, Sylvester Ochieng, Theda Gödecke, and Matin Qaim. 2020. Agricultural commercialisation and nutrition in smallholder farm households. *Journal of Agricultural Economics* 71 (2): 534–555. https://doi.org/10.1111/1477-9552.12359.

Opondo, Florence, George Owuor, Patience Mshenga, Andre Louw, and Daniel Jordan. 2020. Estimation of the effect of cassava commercialization on different household income measurements in Kilifi County. *Kenya. Journal of Sustainable Development* 13 (1): 44–58. https://doi.org/10.5539/jsd.v13n1p44.

Orr, Alastair, Rosario Kambalame, and Peter Porázik. 2021. The discipline of context: Commercializing a "women's crop" in southern Malawi. *Gender, Technology and Development* 25 (3): 251–274. https://doi.org/10.1080/09718524.2021.1939961.

Park, Clara Mi Young., and Margherita Maffii. 2017. 'We are not afraid to die': Gender dynamics of agrarian change in Ratanakiri province, Cambodia. *Journal of Peasant Studies* 44 (6): 1235–1254. https://doi.org/10.1080/03066150.2017.1384725.

Pattnaik, Itishree, and Kuntala Lahiri-Dutt. 2022. Do women like to farm? Evidence of growing burdens of farming on women in rural India. *Journal of Peasant Studies* 49 (3): 629–651. https://doi.org/10.1080/03066150.2020.1867540.

Prügl, Elisabeth, Fenneke Reysoo, and Dzodzi Tsikata. 2021. Agricultural and land commercialization—Feminist and rights perspectives. *The Journal of Peasant Studies* 48 (7): 1419–1438. https://doi.org/10.1080/03066150.2021.1974843.

Razavi, Shahra. 2003. Introduction: Agrarian change, gender and land rights. *Journal of Agrarian Change* 3 (1–2): 2–32. https://doi.org/10.1111/1471-0366.00049.

Razavi, Shahra. 2009. Engendering the political economy of Agrarian change. *Journal of Peasant Studies* 36 (1): 197–226. https://doi.org/10.1080/03066150902820412.

Towns, Alexandra M., and Charlie Shackleton. 2018. Traditional, indigenous, or leafy? A definition, typology, and way forward for African vegetables. *Economic Botany* 72: 461–477. https://doi.org/10.1007/s12231-019-09448-1.

Tsikata, Dzodzi. 2016. Gender, land tenure and Agrarian production systems in Sub-Saharan Africa. *Agrarian South: Journal of Political* 5 (1): 1–19. https://doi.org/10.1177/2277976016658738.

Tuni, Andrea, Athanasios Rentizelas, and Grivin Chipula. 2022. Barriers to commercialise produce for smallholder farmers in Malawi: An interpretive structural modelling approach. *Journal of Rural Studies* 93: 1–17. https://doi.org/10.1016/j.jrurstud.2022.05.003.

Waylen, Georgina. 2000. Gendered political economy and feminist analysis. In *Towards a gendered political economy*, ed. Joanne Cook, Jennifer Roberts, and Georgina Waylen, 14–38. London, New York: Macmillan Press LTD; St. Martin's Press.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Sarah Hackfort is a political scientist working at Humboldt University of Berlin. Her research focuses on the political economy of food and agriculture, sustainability, society-nature relations, gender relations, innovations, and technological transformations. Moreover, she investigates processes of transformations in (re)production and politics of the bioeconomy with a focus on digital innovations in agriculture and food production in different countries across the globe. In her research, she combines critical policy and technology analysis with political economy, political ecology and feminist theory.

Christoph Kubitza is a research associate in agricultural and development economics at Humboldt University of Berlin and the German Institute for Global and Area Studies. He was studying land-use change in Indonesia and its economic, institutional, and demographic effects. He worked also as consultant for several *CGIAR* Research Centers. His major research interests include the economic and social impacts of land-use change and global large-scale land acquisitions in middle- and low-income countries as well as the impacts of innovation and technology adoption in smallholder farming systems.

Arnold Opiyo is an Associate Professor of Horticulture at Egerton University. His current research interest is on African leafy Vegetables. Of specific interest is the reduction of quantitative and qualitative losses

at different stages between production and consumption. Of interest is the application of affordable cooling and packaging technologies for smallholder African Leafy Vegetables farmers. He has several years of experience in teaching and research as well as consultancy in postharvest technology and physiology of horticultural crops. He has led and participated in several projects locally and internationally.

Anne Musotsi is a food scientist and nutritionist with research interests in food security, indigenous foods and bioactive compounds for nutrition and health. She is passionate about working with rural, peri-urban and urban poor communities in Kenya to enhance utilization of food resources and alleviate poverty and malnutrition. She is Lecturer at Masinde Muliro University of Science and Technology, Department of Nutritional Sciences. She has worked on various other projects, attended various international conferences and workshops and provided consultancy in areas of African indigenous vegetables.

Susanne Huyskens-Keil is an agricultural scientist with a research focus on the quality dynamics and postharvest quality management of perishable horticultural crops during the food supply chain. She has a long-standing expertise in academic research, consultancy and teaching in the area of quality evaluation, postharvest physiology, postharvest management of horticultural products and is involved in various national and international projects among them research projects and curriculum development projects with African (Kenya, Tanzania, Uganda, Ghana) and Asian (China, Indonesia, Vietnam) Universities and research institutes.